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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/810,960	03/25/2004	David J. Edlund	NPW 357	9804

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EXAMINER	
AUSTIN, MELISSA J	
ART UNIT	**PAPER NUMBER**
1745	

DATE MAILED: 11/16/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/810,960	EDLUND ET AL.
	Examiner	Art Unit
	Melissa Austin	1745

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *25 March 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-43* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-43* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *25 March 2004* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Priority

1. Acknowledgment is made of applicant's claim for domestic priority to US provisional application serial No. 60/459,866.

Drawings

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: 212. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Information Disclosure Statement

3. The Information Disclosure Statement (IDS) filed on June 14, 2004 has been considered by the examiner.

Specification

4. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

6. Claims 27, 33-35, and 37 are rejected under 35 U.S.C. 102(b) as being anticipated by Nitta et al. (6,106,963). Nitta teaches a fuel cell system in which an air stream is supplied to an oxygen enrichment unit (Figure 1: 34) in which is produced an oxygen-enriched air stream (Figure 2: 67) that is delivered to the cathode side of a fuel cell (Figure 2: 40). The fuel cell produces electromotive force using the oxygen-enriched air stream. The fuel cell exhausts exhaust oxidizing gas, containing water produced by the cell reaction as steam, and the water in the exhaust stream is recovered by a condensed water recovery vessel. This water is recycled to the steam reformer where it is used together with a methanol feed in the production of hydrogen gas for use as fuel for the fuel cell. The mixing ratio of methanol to water causes the reformed gas to contain sufficient steam to be usable as gaseous fuel for supply to fuel cells (Col. 11, ll. 44-Col. 12, ll. 5; Col. 1, ll. 11-15; Col. 8, ll. 31-36).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 1, 2, 5, 7-12, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of Okamoto (6,045,933).

Nitta teaches a fuel cell system equipped with a fuel reformer containing a steam reforming unit and a CO reducing unit (Figure 1: 26, 28, 29; applicant's fuel processing assembly and separation region), an oxygen enrichment unit (Figure 1: 34; applicant's air delivery system) receiving an air stream from which is produced an oxygen enriched air, a fuel cell stack (Figure 1: 40), and a water recovery vessel (Figure 1: 36).

The reformer is provided with feeds of water and methanol (Figure 1: 62, 60; applicant's at least one feed stream) from which it produces a hydrogen-rich reformed gas that is sent to the CO reducing unit where the amount of CO in the gas is reduced to supply a hydrogen-rich fuel (applicant's product hydrogen stream).

The oxygen-enrichment unit is supplied with compressed air as the oxidizing gas (Figure 1: 66) from which it produces an oxygen-enriched gas (that is, raises the oxygen concentration of the oxidizing gas) for delivery to the fuel cell stack. Methods of increasing the oxygen concentration include a nitrogen separator to remove nitrogen, a pressure swing adsorption (PSA) to remove nitrogen, an oxygen permeable membrane to separate oxygen from the other components of air, and a magnetic oxygen enrichment device to separate oxygen from the other components of the air. These methods produce oxygen-enriched streams and oxygen-depleted (or nitrogen-enriched) streams. Since oxygen is being removed from the air, the oxygen-depleted stream has a higher concentration of nitrogen than the incoming air stream.

The fuel cell stack receives hydrogen-rich fuel from the reformer and oxygen-enriched oxidizing gas from the oxygen-enrichment unit (Figure 1: 63, 67) from which it produces an electromotive force (applicant's electric current); the exhaust oxidizing gas (Figure 1: 68; applicant's cathode exhaust stream) contains water that is recovered by the condensed water recovery vessel (Figure 1: 36; applicant's water-recovery assembly) and is sent to a water tank (Figure 1: 22; applicant's product water stream).

(Col. 8, ll. 29-31, 49-52; Col. 9, ll. 35-48; Col. 11, ll. 48-52; Col. 3, ll. 9-18; Col. 1, ll. 56 – Col. 2, ll. 14; Col. 6, ll. 40-49).

Nitta also teaches by Nernst's equation that as the partial pressure of hydrogen (or concentration of hydrogen) in the fuel increases, the electromotive force is elevated and the power generating efficiency of the cell is improved

However, Nitta fails to disclose a purity of the hydrogen-rich fuel.

Okamoto teaches a reformer used in conjunction with a pressure swing adsorption (PSA) device (Figure 2: 14, 72; applicant's separation region). The fuel gas derived from methanol and water in the steam reformer (Figure 2: 78) is supplied to the PSA device "whereby only hydrogen gas" (that is ~100% pure H_2) in the fuel gas is supplied to the hydrogen electrode of the fuel cell (Figure 2: 20: applicant's at least substantially pure hydrogen gas) (Col. 4, ll. 57-50; Col .2, ll. 48-56; Col. 5, ll. 17-25).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have adapted in the fuel cell system as taught by Nitta to provide a very high purity hydrogen gas to the fuel cell stack by incorporating a PSA device that provides only hydrogen gas as the fuel to the fuel cell as taught by Okamoto in order to elevate the electromotive force and improve the power generating efficiency of the fuel cell.

9. Claims 3, 4, and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of Okamoto (6,045,933). Nitta and Okamoto teach the elements of claim 1 as discussed in the above 35 USC 103 rejection, incorporated herein.

Nitta also teaches that the recovered water from the exhaust oxidizing gas is recycled (Figure 1: 69) to the water tank from which water is provided to the reformer.

Okamoto also teaches gas-liquid separators (Figure 2: 48, 50) for separating gas and water exhaust components discharged from the fuel cell. The water is sent to a water tank then as a feed stream to the reformer (Figure 2: 24, 18).

However, neither Nitta nor Okamoto teaches what percentage of the feed stream is made of the recycled water from the water-recovery assembly.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to vary the amount of water in the feed stream in order to provide the appropriate steam to carbon ratio in

the feed to the reformer, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980). Applicant has shown no criticality to the percentage of recycled water in the feed stream and absent a showing of such this rejection stands.

10. Claims 3, 4, and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of Okamoto (6,045,933). Nitta and Okamoto teach the elements of claim 1 as discussed in the above 35 USC 103 rejection, incorporated herein.

Nitta also teaches that the recovered water from the exhaust oxidizing gas is recycled (Figure 1: 69) to the water tank from which water is provided to the reformer.

Okamoto also teaches gas-liquid separators (Figure 2: 48, 50) for separating gas and water exhaust components discharged from the fuel cell. The water is sent to a water tank then as a feed stream to the reformer (Figure 2: 24, 18).

However, neither Nitta nor Okamoto teaches what percentage of the feed stream is made of the recycled water from the water-recovery assembly.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use recycled water from the water-recovery assembly as at least a portion of the feed water to the reformer in order to decrease utility costs. Applicant has shown no criticality to the percentage of recycled water in the feed stream and absent a showing of such this rejection stands.

11. Claims 13-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of Okamoto (6,045,933), and further in view of *Fuel Cell Systems*. Nitta and Okamoto teach the elements of claim 1 as discussed in the above 35 USC 103 rejection, incorporated herein.

However, neither Nitta nor Okamoto teaches the concentration of oxygen in the oxygen-enriched stream.

Fuel Cell Systems teaches that oxygen enriched air streams may be produced from PSA or membrane systems. System optimization studies have shown a PSA system producing a 90% purity oxygen stream from air and a membrane-based system producing a 40% purity oxygen stream.

Air contains 21% oxygen by volume. An oxygen enriched stream having a concentration 50% greater than the concentration of oxygen gas in the air stream would contain:

$$0.21+0.5(0.21) = 0.315 \text{ or } 31.5\% \text{ oxygen.}$$

Likewise, an oxygen enriched stream having a concentration 100% greater than the concentration of oxygen gas in the air stream would contain 42% oxygen. Either the PSA or membrane system would provide at minimum an oxygen-enriched stream containing 40% oxygen.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made that the oxygen-enrichment methods as taught by Nitta produce the purity of at least 30%, at least 50%, and at least 75% oxygen (or an oxygen-enriched stream with an oxygen concentration of 50% or 100% greater than the oxygen concentration of the air stream) since it was known in the art that PSA and membrane systems provide oxygen streams of 90% and 40% purity, respectively, as taught by *Fuel Cell Systems.*

12. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of Okamoto (6,045,933), and further in view of Bostaph et al. (2003/0031908). Nitta and Okamoto teach the elements of claim 1 as discussed in the above 35 USC 103 rejection, incorporated herein.

However, neither Nitta nor Okamoto disclose a water recovery assembly containing a water permeable membrane with the product water stream being formed from water that passes through the membrane.

Bostaph teaches a water recovery and recirculation system in which the cathode exit-flow stream, which contains water produced by the fuel cell, enters a gas-liquid separator tank. The separator tank is made of a hydrophobic air-permeable membrane for separation of air and water. The separated water is collected the gas-separator tank and returned to the recirculating channel through a reverse osmosis membrane (water permeable). This type of water management system eliminates cathode flooding [0022]

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have included a water recovery system comprising a water permeable membrane as taught by Bostaph in the fuel cell system as taught by Nitta and Okamoto in order to eliminate cathode flooding.

13. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of Okamoto (6,045,933), and further in view of Appleby et al. (US 2001/0026884). Nitta and Okamoto teach the elements of claim 1 as discussed in the above 35 USC 103 rejection, incorporated herein.

However, neither Nitta nor Okamoto teaches the product water recovered from the cathode exhaust delivered to a potable water supply.

Appleby teaches that astronauts used water recovered from fuel cells used to power the Gemini space missions as drinking water [0013].

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made that the water recovered from the cathode exhaust of the fuel cell was of high enough purity to serve as a source of potable water since it has been used for that purpose starting with the Gemini space missions in order to decrease the weight of water being carried in a portable fuel cell and decrease the amount of by-product released to the environment.

14. Claims 21-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of Okamoto (6,045,933) and further in view of *Fuel Cell Systems*. Nitta and Okamoto teach the elements of claim 1 as discussed in the above 35 USC 103 rejection, incorporated herein.

However, neither Nitta nor Okamoto teaches the concentration of oxygen in the oxygen-enriched stream or the flow rate off the product water stream from the water-recovery assembly.

Fuel Cell Systems teaches that oxygen enriched air streams may be produced from PSA or membrane systems. System optimization studies have shown a PSA system producing a 90% purity oxygen stream from air and a membrane-based system producing a 40% purity oxygen stream.

Air contains 21% oxygen by volume. An oxygen enriched stream having a concentration 30% greater than the concentration of oxygen gas in the air stream would contain:

$$0.21+0.3(0.21) = 0.273 \text{ or } 27.3\% \text{ oxygen.}$$

Likewise, an oxygen enriched stream having a concentration 100% greater than the concentration of oxygen gas in the air stream would contain 42% oxygen. Either the PSA or membrane system would provide at minimum an oxygen-enriched stream containing 40% oxygen.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made that the oxygen-enrichment methods as taught by Nitta produce an oxygen-enriched stream with an oxygen concentration of 30% greater than the oxygen concentration of the air stream since it was known in the art that PSA and membrane systems provide oxygen streams of 90% and 40% purity, respectively, as taught by *Fuel Cell Systems* and that an increase of the partial pressure of oxygen in the oxidant gas elevates the electromotive force and improves power generating efficiency according to the Nernst equation.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to vary the flow rate of water in the feed stream, and thus the amount of water fed to the reformer, in order to provide the appropriate steam to carbon ratio in the feed to the reformer, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

15. Claims 28 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of Okamoto (6,045,933). Nitta teaches the elements of claim 27 as discussed in the above 35 USC 102 rejection, incorporated herein. Nitta also teaches by Nernst's equation that as the partial pressure of hydrogen (or concentration of hydrogen) in the fuel increases, the electromotive force is elevated and the power generating efficiency of the cell is improved.

However, Nitta fails to disclose a purity of the hydrogen-rich fuel.

Okamoto teaches a reformer used in conjunction with a pressure swing adsorption (PSA) device (Figure 2: 14, 72; applicant's separation region). The fuel gas derived from methanol and water in the

steam reformer (Figure 2: 78) is supplied to the PSA device "whereby only hydrogen gas" (that is ~100% pure H_2) in the fuel gas is supplied to the hydrogen electrode of the fuel cell (Figure 2: 20: applicant's at least substantially pure hydrogen gas) (Col. 4, ll. 57-60; Col .2, ll. 48-56; Col. 5, ll. 17-25).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have adapted in the fuel cell system as taught by Nitta to provide a very high purity hydrogen gas to the fuel cell stack by incorporating a PSA device that provides only hydrogen gas as the fuel to the fuel cell as taught by Okamoto in order to elevate the electromotive force and improve the power generating efficiency of the fuel cell (Nernst's equation).

16. Claims 29-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of *Fuel Cell Systems*. Nitta teaches the elements of claim 27 as discussed in the above 35 USC 102 rejection, incorporated herein. Nitta teaches that the oxygen-enrichment unit is supplied with compressed air as the oxidizing gas (Figure 1: 66) from which it produces an oxygen-enriched gas (that is, raises the oxygen concentration of the oxidizing gas) for delivery to the fuel cell stack. Methods of increasing the oxygen concentration include a nitrogen separator to remove nitrogen, a pressure swing adsorption (PSA) to remove nitrogen, an oxygen permeable membrane to separate oxygen from the other components of air, and a magnetic oxygen enrichment device to separate oxygen from the other components of the air. (Col. 1, ll. 56- Col. 2, ll. 14)

Nitta also teaches by Nernst's equation that as the partial pressure of hydrogen (or concentration of hydrogen) in the fuel increases, the electromotive force is elevated and the power generating efficiency of the cell is improved.

However, Nitta fails to teach the concentration of oxygen in the oxygen-enriched stream.

Fuel Cell Systems teaches that oxygen enriched air streams may be produced from PSA or membrane systems. System optimization studies have shown a PSA system producing a 90% purity oxygen stream from air and a membrane-based system producing a 40% purity oxygen stream.

Air contains 21% oxygen by volume. An oxygen enriched stream having a concentration 50% greater than the concentration of oxygen gas in the air stream would contain:

$$0.21+0.5(0.21) = 0.315 \text{ or } 31.5\% \text{ oxygen.}$$

Likewise, an oxygen enriched stream having a concentration 100% greater than the concentration of oxygen gas in the air stream would contain 42% oxygen. Either the PSA or membrane system would provide at minimum an oxygen-enriched stream containing 40% oxygen.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made that the oxygen-enrichment methods as taught by Nitta produce the purity of at least 30%, at least 50%, and at least 75% oxygen (or an oxygen-enriched stream with an oxygen concentration of 50% or 100% greater than the oxygen concentration of the air stream) since it was known in the art that PSA and membrane systems provide oxygen streams of 90% and 40% purity, respectively, as taught by *Fuel Cell Systems.* This increase in oxygen concentration would result in elevated electromotive force and improved power generating efficiency of the cell.

17. Claim 36 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of *Fuel Cell Systems*.

Nitta teaches a fuel cell system in which an air stream is supplied to an oxygen enrichment unit (Figure 1: 34) in which is produced an oxygen-enriched air stream (Figure 2: 67) that is delivered to the cathode side of a fuel cell (Figure 2: 40). Methods of increasing the oxygen concentration include a nitrogen separator to remove nitrogen, a pressure swing adsorption (PSA) to remove nitrogen, an oxygen permeable membrane to separate oxygen from the other components of air, and a magnetic oxygen enrichment device to separate oxygen from the other components of the air. (Col. 1, ll. 56- Col. 2, ll. 14). The fuel cell produces electromotive force using the oxygen-enriched air stream. The fuel cell exhausts exhaust oxidizing gas, containing water produced by the cell reaction as steam, and the water in the exhaust stream is recovered by a condensed water recovery vessel. This water is recycled to the steam reformer where it is used together with a methanol feed in the production of hydrogen gas for use as fuel for the fuel cell. The mixing ratio of methanol to water causes the reformed gas to contain sufficient steam to be usable as gaseous fuel for supply to the anode side of the fuel cells (Col. 11, ll. 44-Col. 12, ll. 5; Col. 1, ll. 11-15; Col. 8, ll. 31-36; Col. 10, ll. 36-39).

Nitta also teaches by Nernst's equation that as the partial pressure of hydrogen (or concentration of hydrogen) in the fuel increases, the electromotive force is elevated and the power generating efficiency of the cell is improved.

However, Nitta does not teach the concentration of oxygen in the oxygen-enriched stream.

Fuel Cell Systems teaches that oxygen enriched air streams may be produced from PSA or membrane systems. System optimization studies have shown a PSA system producing a 90% purity oxygen stream from air and a membrane-based system producing a 40% purity oxygen stream.

Air contains 21% oxygen by volume. An oxygen enriched stream having a concentration 50% greater than the concentration of oxygen gas in the air stream would contain:

$$0.21+0.5(0.21) = 0.315 \text{ or } 31.5\% \text{ oxygen.}$$

Either the PSA or membrane system would provide at minimum an oxygen-enriched stream containing 40% oxygen.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made that the oxygen-enrichment methods as taught by Nitta produce an oxygen-enriched stream with an oxygen concentration of 50% since it was known the art that PSA and membrane systems provide oxygen streams of 90% and 40% purity, respectively, as taught by *Fuel Cell Systems*. This increase in oxygen concentration would result in elevated electromotive force and improved power generating efficiency of the cell.

18. Claims 38-43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nitta et al. (6,106,963) in view of *Fuel Cell Systems*. Nitta teaches the elements of claim 37 as discussed in the above 35 USC 102 rejection, incorporated herein. Nitta also teaches methods of increasing the oxygen concentration in the oxygen-enrichment device include a nitrogen separator to remove nitrogen, a pressure swing adsorption (PSA) to remove nitrogen, an oxygen permeable membrane to separate oxygen from the other components of air, and a magnetic oxygen enrichment device to separate oxygen from the other components of the air.

However, Nitta fails to teach the concentration of oxygen in the oxygen-enriched stream or the flow rate off the product water stream from the water-recovery assembly.

Fuel Cell Systems teaches that oxygen enriched air streams may be produced from PSA or membrane systems. System optimization studies have shown a PSA system producing a 90% purity oxygen stream from air and a membrane-based system producing a 40% purity oxygen stream.

Air contains 21% oxygen by volume. An oxygen enriched stream having a concentration 30% greater than the concentration of oxygen gas in the air stream would contain:

$$0.21+0.3(0.21) = 0.273 \text{ or } 27.3\% \text{ oxygen.}$$

Likewise, an oxygen enriched stream having a concentration 100% greater than the concentration of oxygen gas in the air stream would contain 42% oxygen. Either the PSA or membrane system would provide at minimum an oxygen-enriched stream containing 40% oxygen.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made that the oxygen-enrichment methods as taught by Nitta produce an oxygen-enriched stream with an oxygen concentration of 30% greater than the oxygen concentration of the air stream since it was known in the art that PSA and membrane systems provide oxygen streams of 90% and 40% purity, respectively, as taught by *Fuel Cell Systems* and that an increase of the partial pressure of oxygen in the oxidant gas elevates the electromotive force and improves power generating efficiency according to the Nernst equation.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to vary the flow rate of water in the feed stream, and thus the amount of water fed to the reformer, in order to provide the appropriate steam to carbon ratio in the feed to the reformer, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Melissa Austin whose telephone number is (571) 272-1247. The examiner can normally be reached on Monday - Thursday, alt. Friday, 7:15 AM - 4:15 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on (571) 272-1292. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

mja

Melissa Austin
Patent Examiner
Art Unit 1745
1.

Gregg Cantelmo
Primary Examiner
A.U. 1745